

Medicina-Noto line VLBI observations are driven by a (standard) VLBI schedule that synchronizes movements and recordings of the two telescopes. The instructions for scheduling VLBI observations with EVN telescopes can be found at the web location:

`"http://www.evlbi.org/scheduling/scheduling.html"`

New users should read the "EVN PI Instruction Sheet" for a general introduction and, besides, the section `"http://www.evlbi.org/scheduling/evn_line.html"`, which gives specific indications for line VLBI.

VLBI schedules can be prepared using the program SCHED, whose documentation and source code are available at the web locations:

`"http://www.aoc.nrao.edu/cwalker/sched/sched/sched.html"`

and

`"ftp://ftp.aoc.nrao.edu/pub/sched"`

Examples of line VLBI schedules can be found at:

`"http://www.evlbi.org/scheduling/evnkey/evnkey.html"`

where the file `"evn_line_meth.key"` is an example of VLBI schedule to observe the 6.7 GHz methanol masers.

In the following the various sections of the VLBI schedule for line observations are taken into consideration and points which deserve specific care are outlined.

Cover Information

It is recommended using "note1-4" to describe concisely: 1) that is a spectral line experiment and the PHASE-CAL MUST BE OFF; 2) whether it is a phase-reference observation; 3) whether it is a multi-epoch experiment, and, if so, giving the number of epochs and the time separation between consecutive epochs.

Correlator Information

The velocity resolution is defined by means of two parameter: "corchan", which gives the number of correlator channels, and "bbfilter" (defined in the section "Setup Information"), which sets the single IF baseband width (in MHz). Since, owing to the odd shapes of the baseband filters, generally only 60–70% of the baseband is flat, it is advisable to use a baseband width significantly larger (say, twice) than the maser emission range. The velocity resolution should be enough to resolve the emission profile of the single maser spot (for instance, $\approx 0.2 \text{ km s}^{-1}$ for 6.7 GHz CH₃OH and $\approx 0.5 \text{ km s}^{-1}$ for 22.2 GHz H₂O masers). The parameter "corsrcs = 'from schedule'" can be used to specify that the positions of the target sources have to be taken from the "Source Catalog" of the schedule.

Source Catalog

For line observations, the field of view of the VLBI array is limited by time-smearing. Using a standard integration time for the cross-correlation of the visibilities of 2 s, the Noto-Medicina baseline has an instantaneous field of view of ≈ 50 arcsec in C band and ≈ 10 arcsec in K band. The maser target(s) position has to be accurate within a small fraction of the instantaneous field of view. For instance, positions of the 6.7 GHz CH₃OH and 22.2 GHz H₂O masers have to be known within an uncertainty of ≤ 10 arcsec and ≤ 2 arcsec, respectively. The LSR velocity of the maser target has to be given with the parameter "vel", which is used by SCHED to derive the observing frequency.

Setup Information

When possible, it is advisable to assign the same frequency (for each polarization) to two different IF basebands, to reduce the risk of losing data in case of bad recording. For line VLBI, 2 bit sampling is recommended for obtaining higher sensitivity in each of the spectral channels. 2 bit sampling can be specified with the command: "bits = 2". The maximum standard recording bit-rate is 128 Mbit/sec, which corresponds to using a total IF band of 16 MHz for each (left and right-circular) polarization. A total recording band of 16 MHz can be obtained using either a single IF baseband with width of 16 MHz, or multiple IF basebands of lower extent. The parameters "nchan" and "bbfilter" serve to define the number of IF basebands (for each polarization) and the single baseband width (in MHz). The command "pcal = 'off'" specifies that, for line observations, the PHASE-CAL signal is switched off, BUT, since at some EVN stations the PHASE-CAL is still under manual control, is recommended to INFORM ALL RELEVANT OBSERVATORY FRIENDS BY E-MAIL.

The Scans

Mk5 EVN observations now use disks (and not longer tapes) to record the data. The SCHED ancillary catalog file "stations.dat" assigns disk-like property to each EVN station by means of the parameters: "DISK = MARK5A", "MEDIADef = DISK". Then, for EVN stations, the default recording media are disks and mark5 rules are set for the used disks. Mk5 EVN experiments free users from worrying about fitting recording scans into 22- or 44-min tape passes, from having 2-min gap at direction-changes, and 10-15min gaps at tape changes. Also no problem bringing stations in/out at various times without worrying about tape-pass synchronization.

If gaps are scheduled between source scans (such as well commands "dwell" or "gaps" are used), the recording operation is halted. Only if gaps are small, less than 8 seconds times the speed-up factor (usually 2), continuous recording is preserved. Whenever recording is halted, resynchronization of the signals will be necessary on replay at the correlator, and a certain amount of data will thus be lost from the beginning of the next scan. For observations including short scans (<1 minute) this may be unacceptable. Generally, phase-referencing observations require continuous recording operation, by scheduling a small, or no, gap. One way to do this is to use the command "duration" rather than "dwell" to specify scan times and to set "gap = 0" to require that no time interval will be scheduled between scans.

In the following pages, an example of schedule to perform 6.7 GHz (methanol maser) Medicina-Noto VLBI is presented

```
! =====
! =====
!
! Experiment MN502 (6.7 GHz methanol maser Medicina-Noto)
!
! =====
!
! Cover information:

EXPT = '6.7 GHz CH3OH masers'
EXPCODE = 'MN502'
VERSION = 1

PINAME = 'PI name & lastname'
ADDRESS1 = 'PI Address : first line'
ADDRESS2 = 'PI Address : second line'
ADDRESS3 = 'PI Address : third line'
ADDRESS4 = 'PI Address : third line'
PHONE = 'PI Telephone number'
FAX = 'PI Fax number'
EMAIL = 'PI e-mail'
OBSMODE = '5cm MKV setup'
! Indicate MKIV setup, since MKV is not yet contemplated
OBSTYPE = 'MKIV'
!
!
! Indicate below which correlator will be used.
! In this case, the MPIfR Bonn correlator is indicated.
CORREL = 'Bonn'
!
! Use "note1–note4" for relevant observing informations
note1 = 'This is a PHASE REF experiment, DO NOT INTERRUPT the SEQUENCE'
note2 = 'of SCANS'
note3 = 'SPECTRAL LINE observations: Make sure *** PHASE CAL is OFF***'
!
!
! Correlator information
CORREL = 'Bonn'
!
! Give in the next line integration time in seconds
CORAVG = 0.5
!
! Give in the next line the number of correlator channels
CORCHAN = 1024 !
```

```

CORNANT = 2
CORPOL = 'off'
CORWTFN = 'uniform'
CORSRCS = 'SCHEDULE'
CORTAPE = DAT
!
! Use "cornote1-cornote4" for relevant correlation informations
CORNOTE1 = 'The positions of the two phase centers are to be taken'
CORNOTE2 = 'from the "source" section of the keyin file'
!
! Shipping address for correlator output
CORSHIP1 = 'PI Address: first line'
CORSHIP2 = 'PI Address: second line'
CORSHIP3 = 'PI Address: third line'
!
!
! Allow SCHED to overwrite existing files
overwrit
!
!
! Source catalogue included
srccat /
!
source='IRAS20126'
ra=20:14:26.044 dec=+41:13:33.39 epoch='J2000' vel=-6.2
REMARKS='target maser source' /
SOURCE='J2007+4029'
RA=20:07:44.944851 DEC= 40:29:48.60414 epoch='J2000'
REMARKS='phase reference for the maser target' /
!
!
! Phase continuum calibrators
!
SOURCE='1955+51','1954+513','1954+513','J1955+51'
RA=19:55:42.7382736 DEC= 51:31:48.546230 epoch='J2000' CALCODE='N'
REMARKS='ICRF - Ext.1 Source - 1998 IERS Annual Report' /
SOURCE='2005+77','2007+777','2007+777','J2005+77'
RA=20:05:30.9985199 DEC= 77:52:43.247608 epoch='J2000' CALCODE='N'
REMARKS='ICRF - Ext.1 Source - 1998 IERS Annual Report' /
SOURCE='2202+42','2200+420','BLLAC','J2202+42','VR42220'
RA=22:02:43.2913780 DEC= 42:16:39.979939 epoch='J2000' CALCODE='N'
REMARKS='ICRF - Ext.1 Source - 1998 IERS Annual Report' /
endcat /
!
! No external source file
srcfile = none
!
! Give YOUR SPECIFIC path for the SCHED Station Catalog "stations.dat"

```

```

staffile = '/aips/programs/SCHED/catalogs/stations.dat'
!
! Spectral line rest frequency
LINEINIT /
lineset = 'CH3OH' restfreq= 6668.5192 /
ENDLINES /
!
! Observing set-up
! Get frequency information from the DEFAULT catalog
! Give YOUR SPECIFIC path for the SCHED frequency catalog "freq.dat"
freqfile = '/aips/programs/SCHED/catalogs/freq.dat'
!
setinit = mn502.set /
! Four IF basebands
nchan = 4
!
! 2 bit sampling
bits = 2
!
! single IF baseband 2 MHz wide
bbfilter = 2.0
!
freqref = 6668.0
freqoff = 0.0, 0.0, 1.0, 1.0
!
! double (left and right) polarization
pol = dual
!
! Set phase-cal signal off, BUT at some station phase-cal is set up manually !
pcal = 'off'
!
barrel=roll_off /
endset /
!
!
! items to list in the ".sum" file
! list elevation at scan start and end, and dwell and slew times
sumitem = el1, el2, dwell, slew
!
!
! START OF PROPER SCHEDULE
! starting March 27 UT = 00:00:00 (2006)
month = 3 day = 27 year = 2006
start = 00:00:00
!
LINENAME = 'CH3OH' DOPPLER
!
SETUP = 'mn502.set'

```

```

!
!
stations = MEDICINA,NOTO
!
!
! delay and bandpass calibrator
source = '1955+51' dur=00:05:00 DOPSRC='IRAS20126' /
!
! 15 cycles of 5.5 min on the maser-phase-reference couple
group 2 repeat 15
source = 'IRAS20126' dur=00:02:30 gap=00:00:00 DOPSRC='IRAS20126' /
source = 'J2007+4029' dur=00:03:00 DOPSRC='IRAS20126' /
!
!
! scan on the fringe-finder: delay, rate, bandpass calibration
source = '2007+777' dwell=00:10:00 DOPSRC='IRAS20126' /
!
! 15 cycles of 5.5 min on the maser-phase-reference couple
group 2 repeat 15
source = 'IRAS20126' dur=00:02:30 gap=00:00:00 DOPSRC='IRAS20126' /
source = 'J2007+4029' dur=00:03:00 DOPSRC='IRAS20126' /
!
!
! delay and bandpass calibrator
source = '1955+51' dur=00:05:00 DOPSRC='IRAS20126' /
!
! 15 cycles of 5.5 min on the maser-phase-reference couple
group 2 repeat 15
source = 'IRAS20126' dur=00:02:30 gap=00:00:00 DOPSRC='IRAS20126' /
source = 'J2007+4029' dur=00:03:00 DOPSRC='IRAS20126' /
!
!
! delay and bandpass calibrator
source = '1955+51' dur=00:05:00 DOPSRC='IRAS20126' /
!
! 21 cycles of 5.5 min on the maser-phase-reference couple
group 2 repeat 21
source = 'IRAS20126' dur=00:02:30 gap=00:00:00 DOPSRC='IRAS20126' /
source = 'J2007+4029' dur=00:03:00 DOPSRC='IRAS20126' /
!
!
! scan on the fringe-finder: delay, rate, bandpass calibration
source = '2007+777' dwell=00:15:00 DOPSRC='IRAS20126' /
!
! Continue to observe calibrators since Medicina and Noto antennae
! are too close to elevation = 90.0 degree
!
! delay and bandpass calibrator

```

```

source = '1955+51' dur=00:15:00 DOPSRC='IRAS20126' /
!
! scan on the fringe-finder: delay, rate, bandpass calibration
source = '2007+777' dwell=00:15:00 DOPSRC='IRAS20126' /
!
! delay and bandpass calibrator
source = '1955+51' dur=00:10:00 DOPSRC='IRAS20126' /
!
! Noto and Medicina antennae have again elevations below 85 degree
!
! 15 cycles of 5.5 min on the maser-phase-reference couple
group 2 repeat 15
source = 'IRAS20126' dur=00:02:30 gap=00:00:00 DOPSRC='IRAS20126' /
source = 'J2007+4029' dur=00:03:00 DOPSRC='IRAS20126' /
!
!
! delay and bandpass calibrator
source = '1955+51' dur=00:05:00 DOPSRC='IRAS20126' /
!
! 15 cycles of 5.5 min on the maser-phase-reference couple
group 2 repeat 15
source = 'IRAS20126' dur=00:02:30 gap=00:00:00 DOPSRC='IRAS20126' /
source = 'J2007+4029' dur=00:03:00 DOPSRC='IRAS20126' /
!
!
! scan on the fringe-finder: delay, rate, bandpass calibration
source = 'BLLAC' dwell=00:10:00 DOPSRC='IRAS20126' /

```